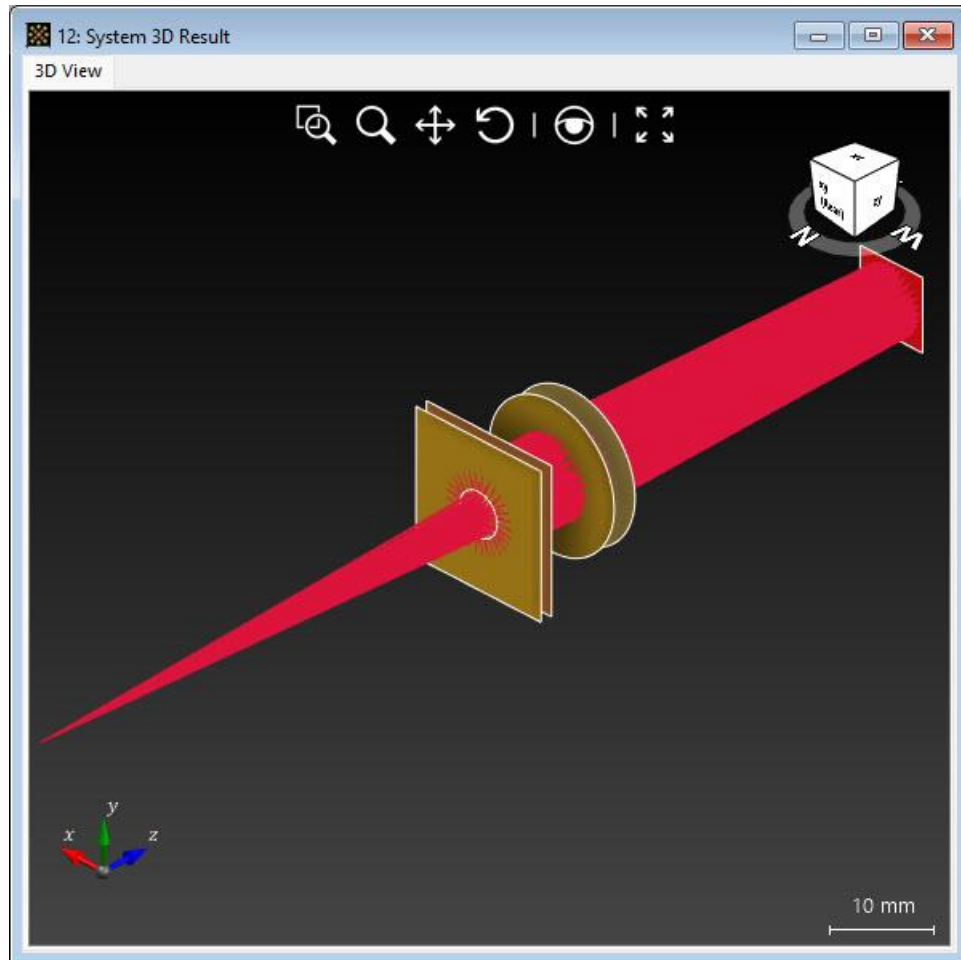# 3D Visualization of Optical Systems

Abstract

For a fundamental understanding of the properties of an optical system, a visualization of its components together with an indication of the light propagation is immensely helpful. For this purpose, VirtualLab Fusion provides tools which display a three-dimensional visualization of optical systems. These tools can further be used to check the positions of elements and detectors, as well as to get a quick overview of the light propagation inside the system. The applied modeling technique for the 3D view is similar to ray tracing.

How to Generate a System View Document

option #1
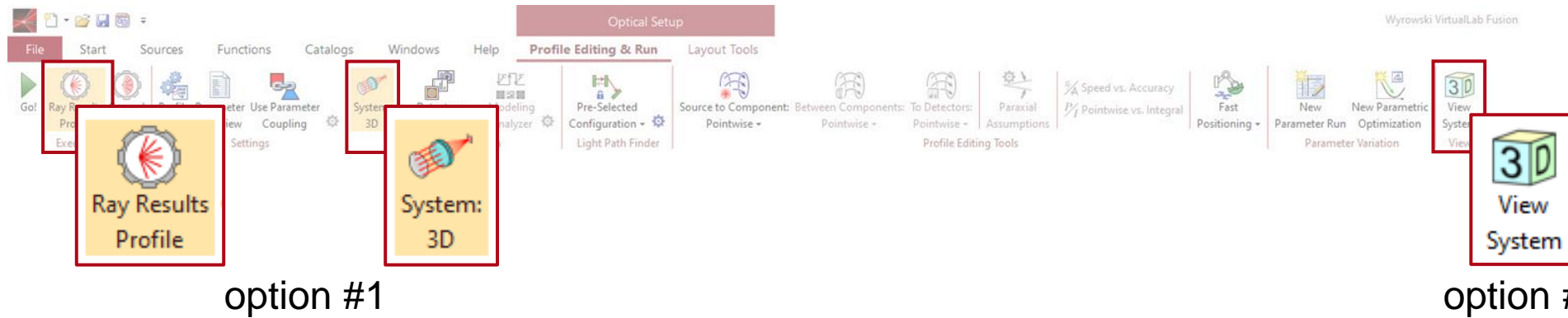
option #2

3D views of an optical system can be generated in two different ways:

1. Use *Ray Results Profile* and choose *System: 3D* as result, then run the simulation.

2. Click on *View System* (just 3D-display of the components, no light propagation).
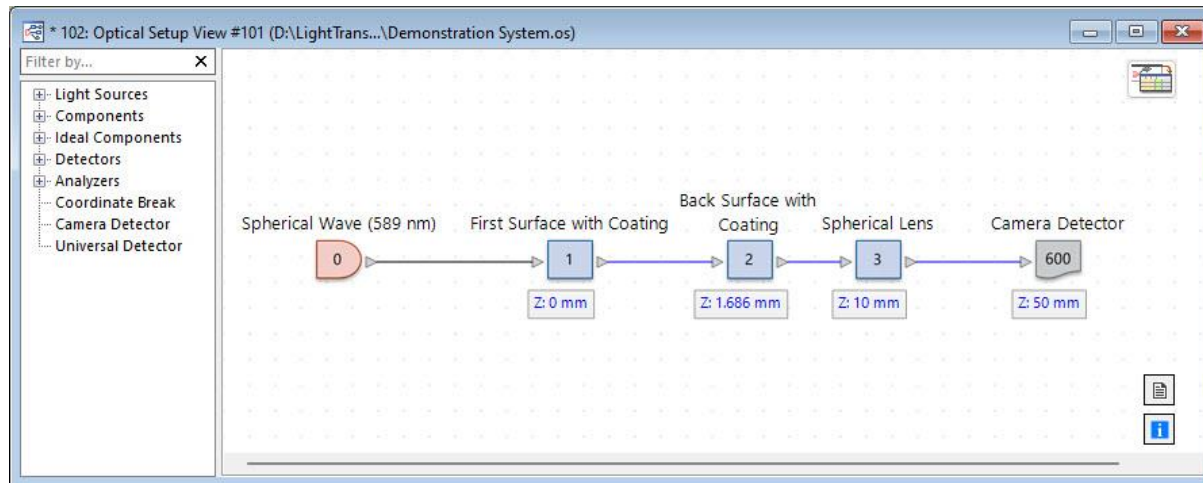
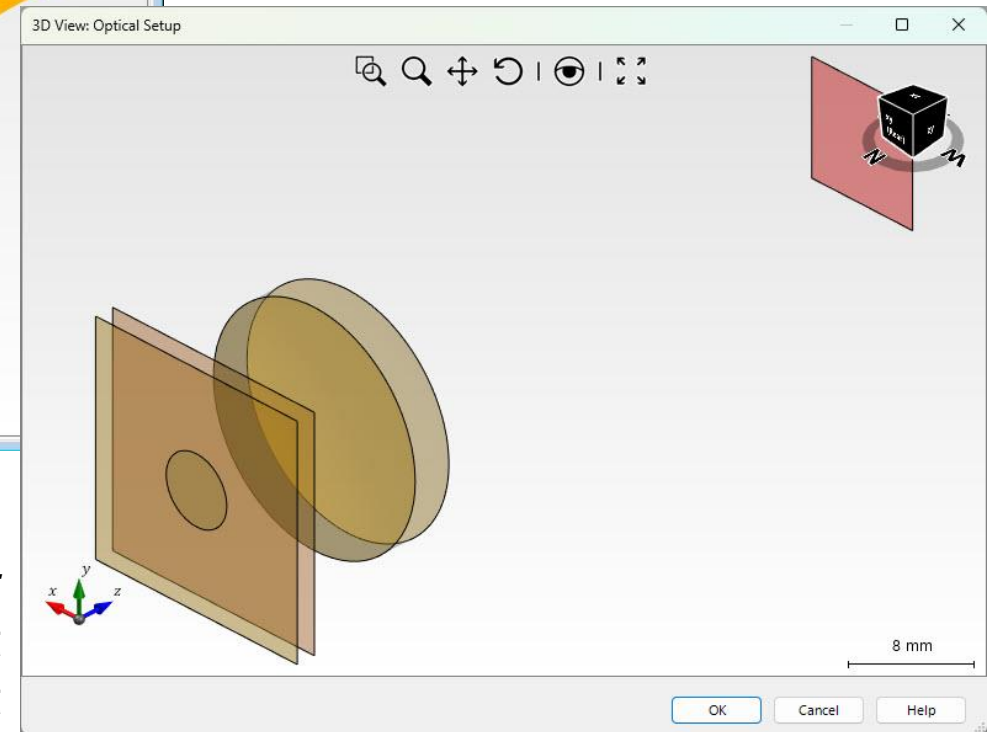# System: 3D (Ray Result Profile) vs. 3D System View

The major difference between the two methods is that the first also provides information about the propagating light by using the *Ray Results Profile*, while in the latter only components and detectors will be displayed.

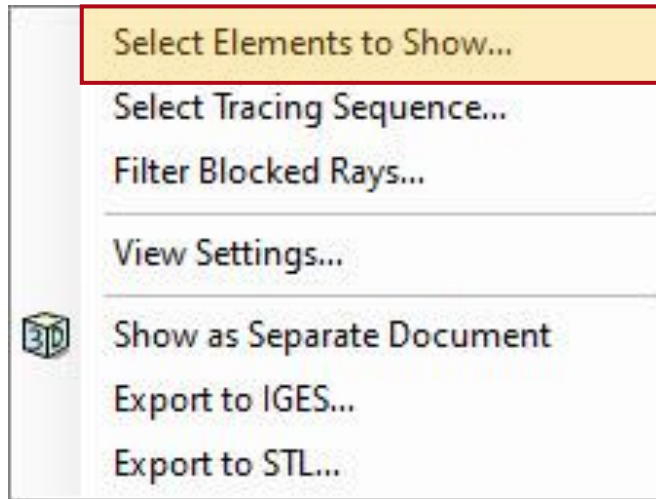We will focus on the *System: 3D* view for the rest of the use case.
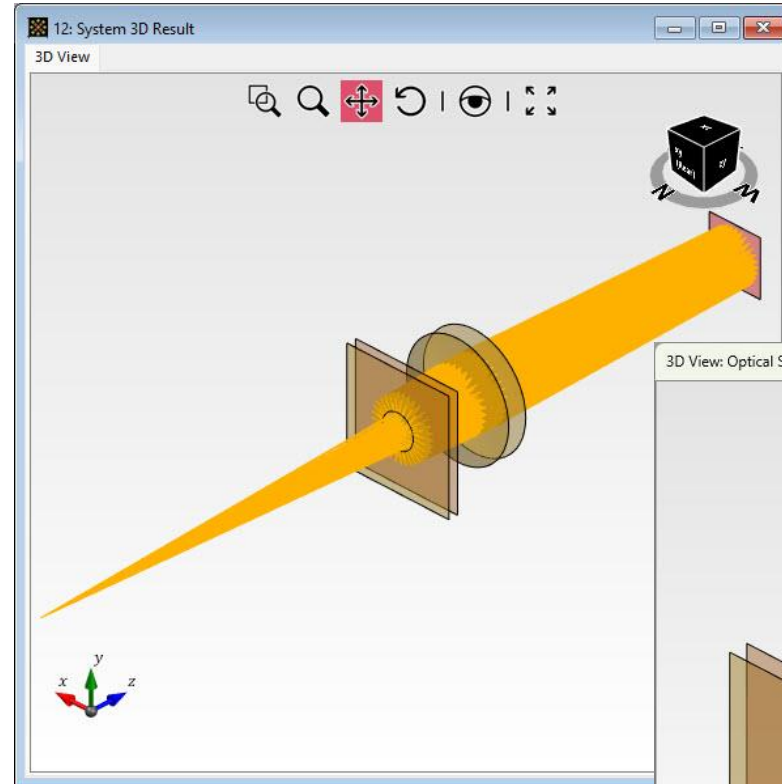
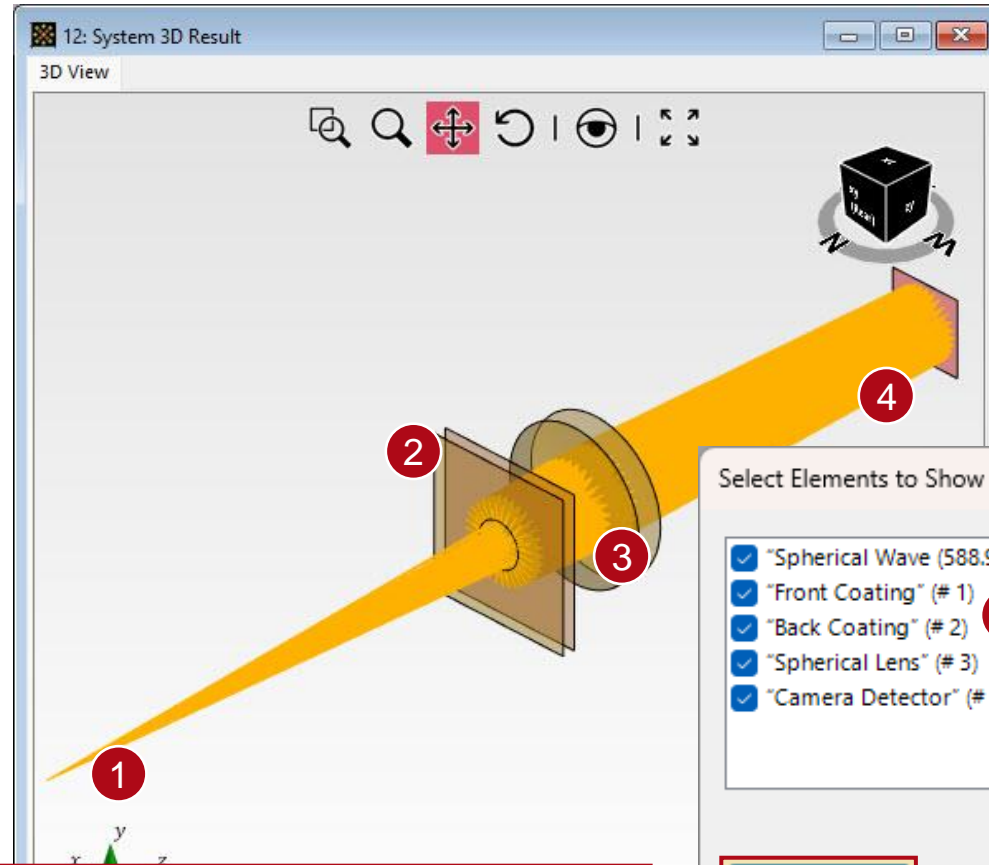*System: 3D* view for *Ray Results Profile*

3D System View: system visualization without depiction of light

Options – Select Elements to Show

Select Elements to Show...
Select Tracing Sequence...
Filter Blocked Rays...

View Settings...

Show as Separate Document
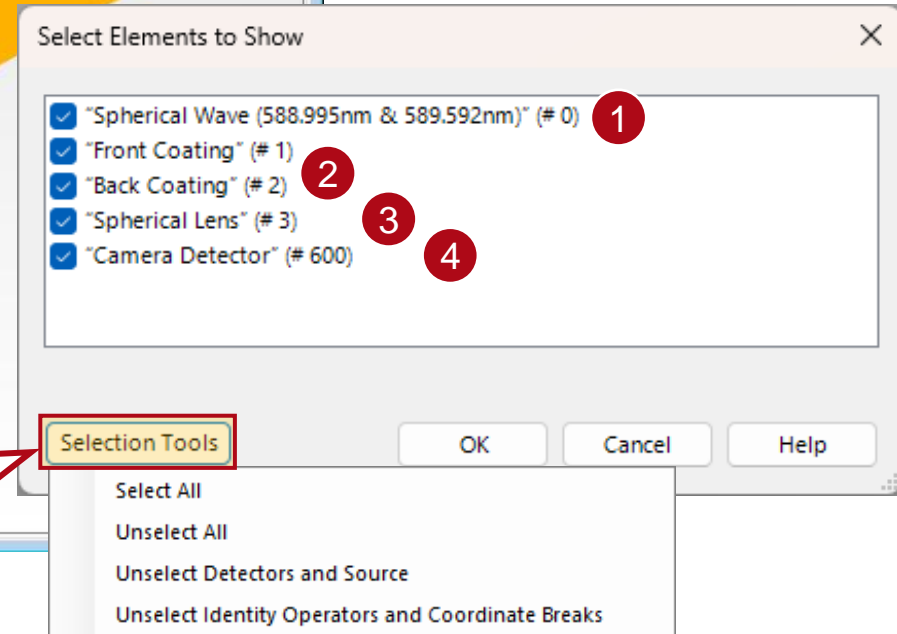Export to IGES...
Export to STL...

A menu providing detailed options is available by right-clicking on the document window. The first option "*Select Elements to Show*" allows the configuration of the elements of the system which are shown in the document (by default all elements are shown).
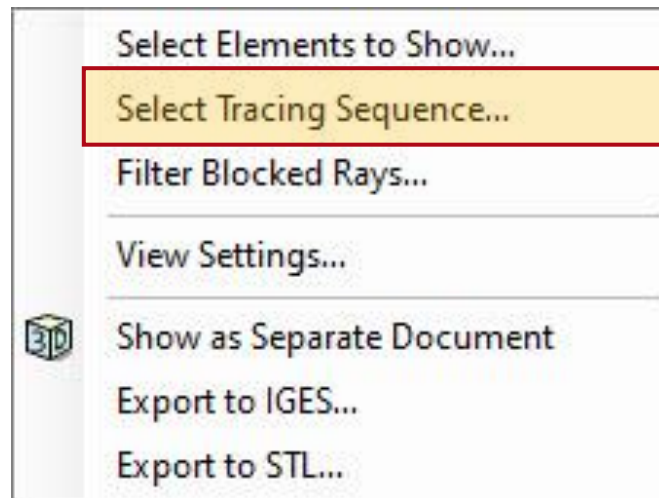
12: System 3D Result
3D View

Fabry-Perot Etalon

See full use case:
Examination of Sodium D Lines with Etalon

Select Elements to Show

✓ "Spherical Wave (588.995nm & 589.592nm)" (# 0)   **1**
✓ "Front Coating" (# 1)   **2**
✓ "Back Coating" (# 2)
✓ "Spherical Lens" (# 3)   **3**
✓ "Camera Detector" (# 600)   **4**

Selection Tools   OK   Cancel   Help

Select All
Unselect All
Unselect Detectors and Source
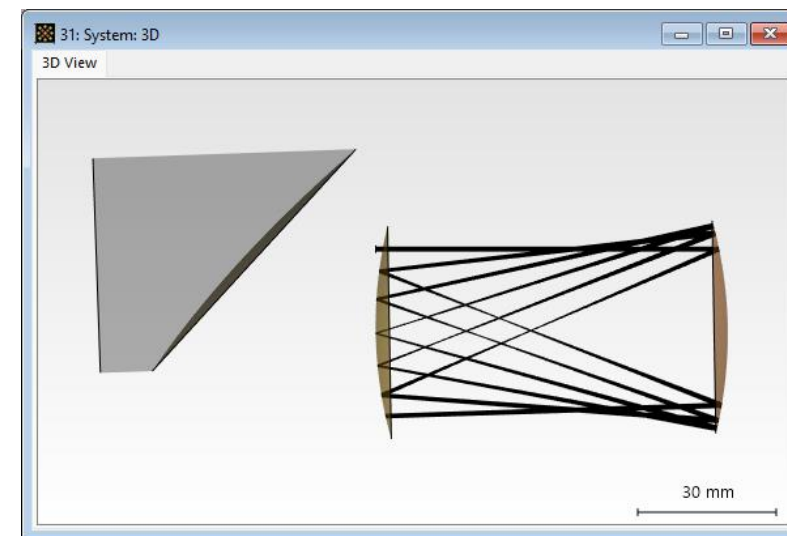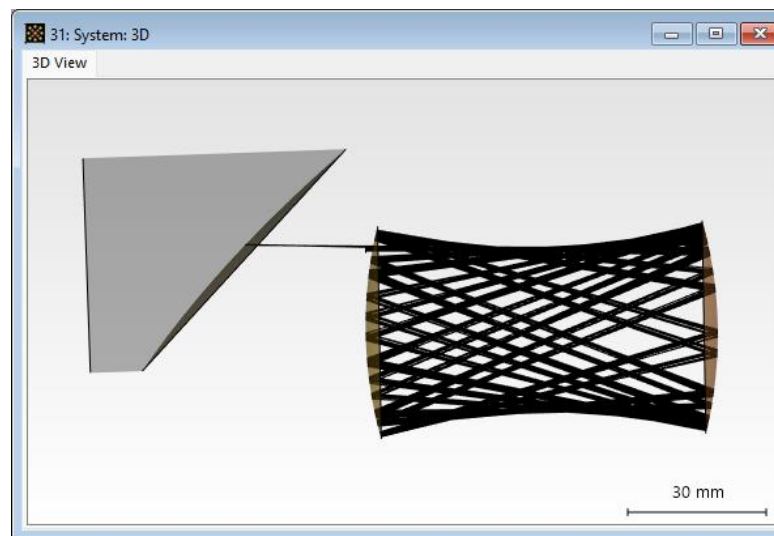Unselect Identity Operators and Coordinate Breaks

If the system has many elements, *Selection Tools* can be useful to ease the workload.

Options – Select Tracing Sequence

Select Elements to Show...
Select Tracing Sequence...
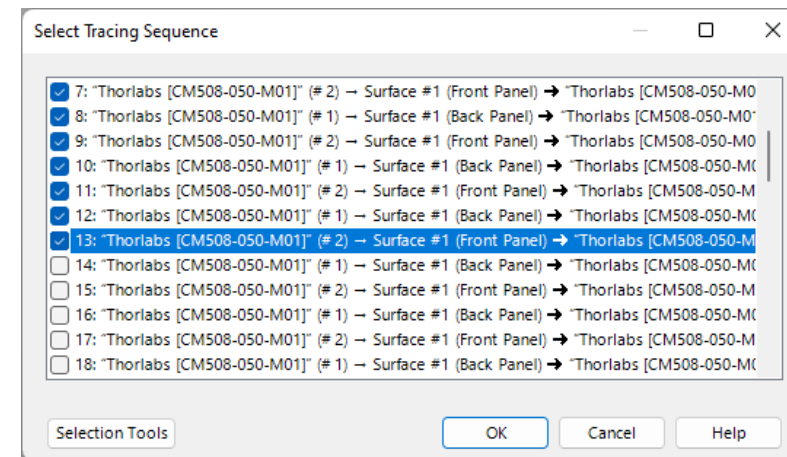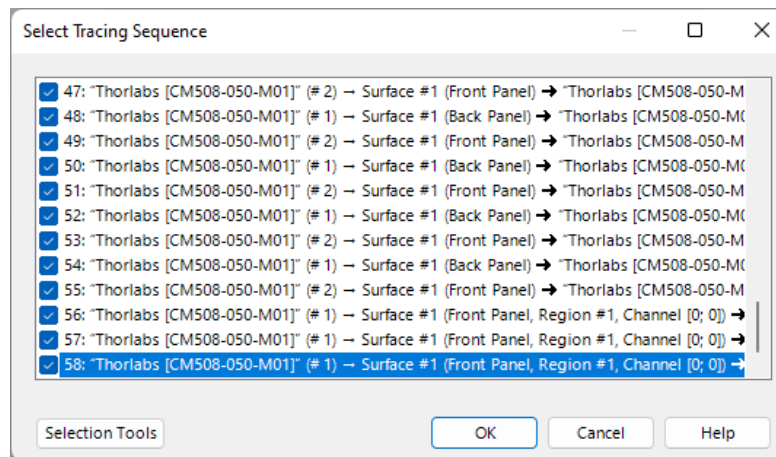Filter Blocked Rays...
View Settings...
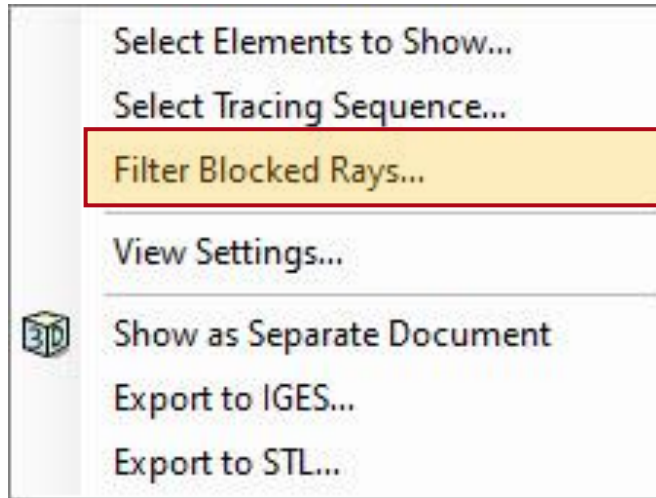Show as Separate Document
Export to IGES...
Export to STL...

example: Herriott Cell – See full use case: Modeling of a Herriott Cell

In case of non-sequential propagation (manual channel configuration) many light paths can be available in the system. The option *"Select Tracing Sequence"* allows the user to select or de-select certain propagation steps for display in the view (by default all light paths are shown).

Options – Filter Blocked Rays

Select Elements to Show...

Select Tracing Sequence...

Filter Blocked Rays...

View Settings...

Show as Separate Document
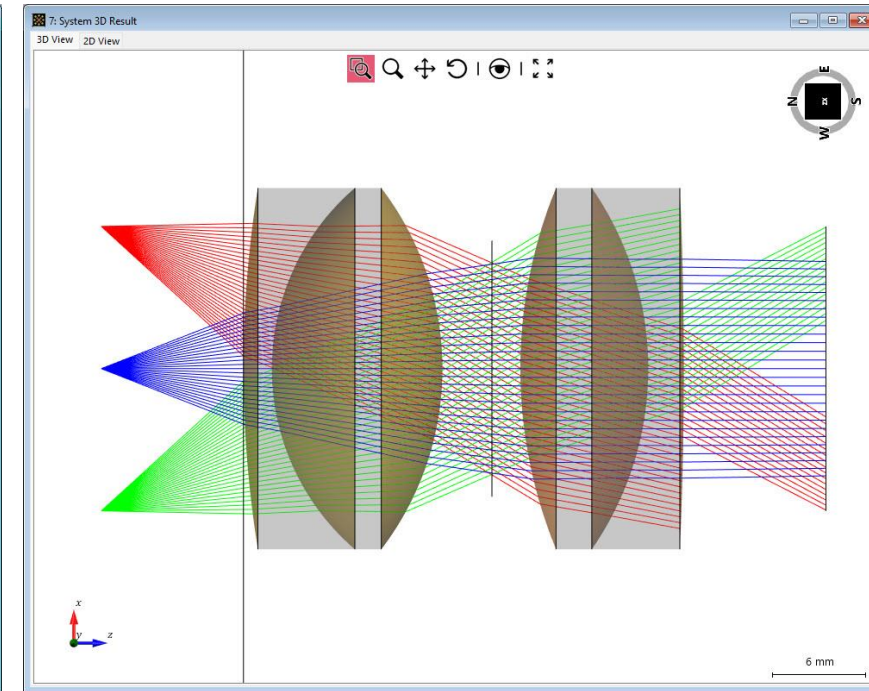
Export to IGES...

Export to STL...

For the sake of clarity, it is possible to filter out all rays that do not pass through a certain aperture in the sequence.

no filter

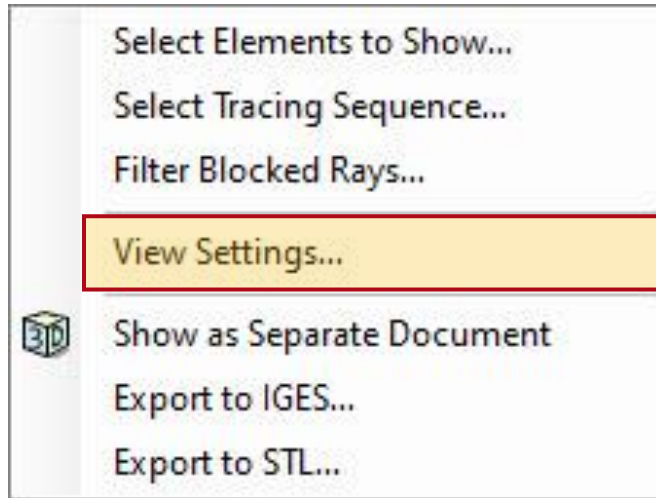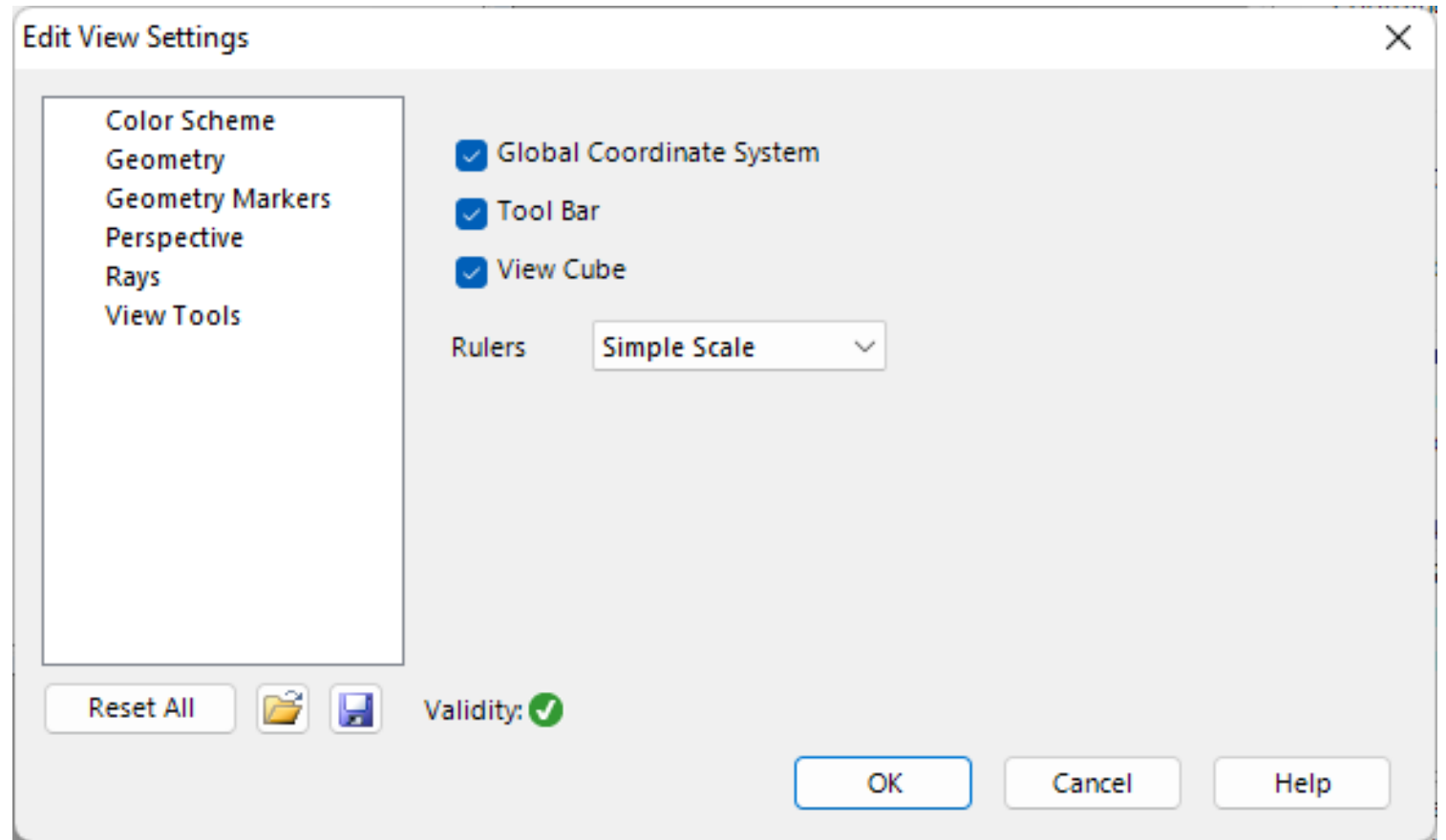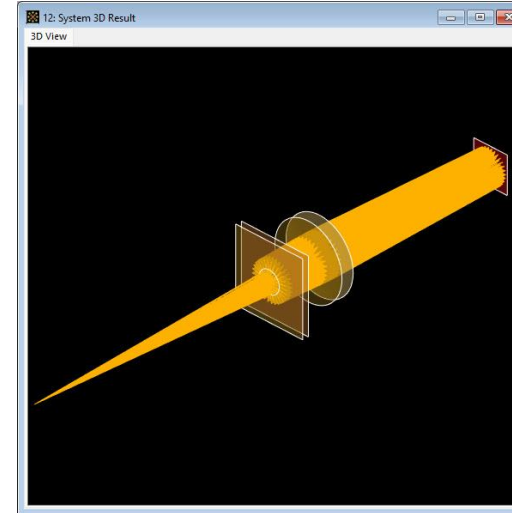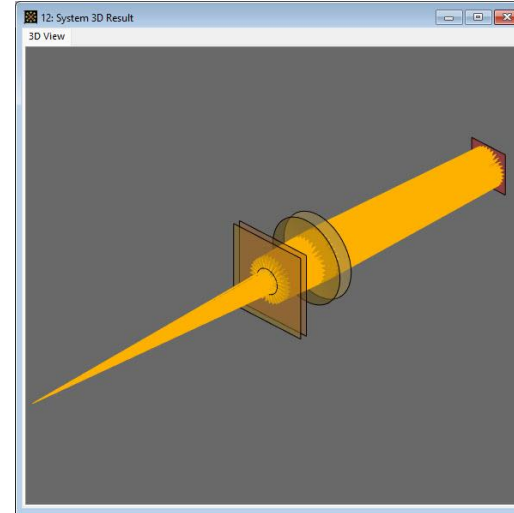with filter

Filter for Blocked Rays

☐ Filter Blocked Rays

OK   Cancel   Help

Filter for Blocked Rays

☑ Filter Blocked Rays

Filter Boundary   5: "Aperture" (# 4) → Surface #1 (Back Panel)

OK   Cancel   Help

Options – View Settings

Select Elements to Show...
Select Tracing Sequence...
Filter Blocked Rays...

View Settings...

Show as Separate Document
Export to IGES...
Export to STL...
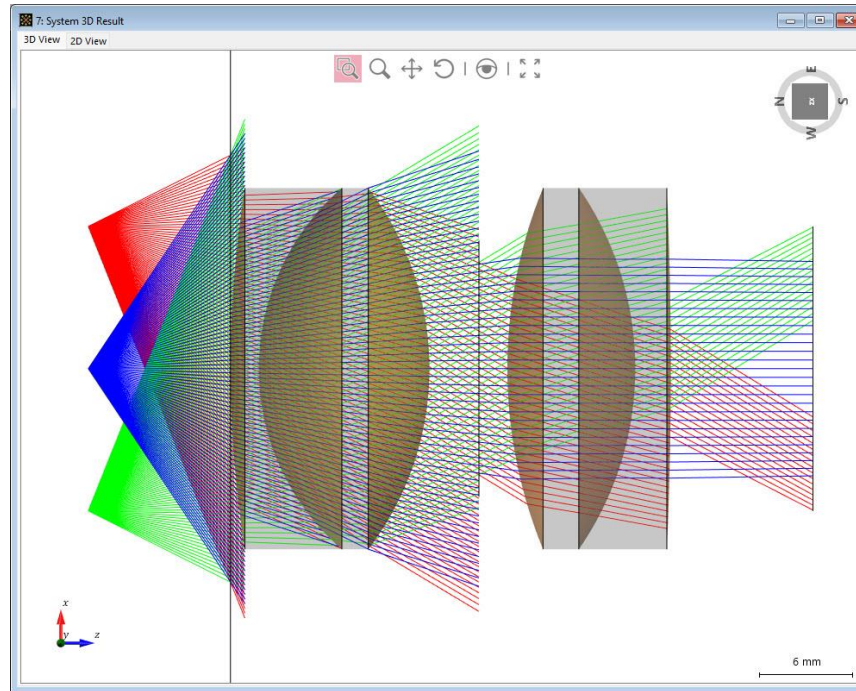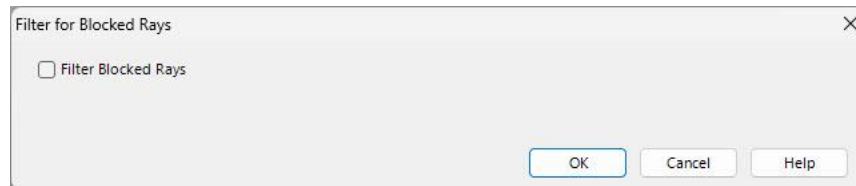
View Settings will open another menu with various options to customize the 3D view, like *Color Scheme*, *View Tools* or depiction style of rays, etc.

Edit View Settings   ✕

Color Scheme
Geometry
Geometry Markers
Perspective
Rays
View Tools

☑ Global Coordinate System

☑ Tool Bar

☑ View Cube

Rulers | Simple Scale   ∨ |

Reset All   📁 💾   Validity: ✅

OK   Cancel   Help

# Color Schemes – Background Color
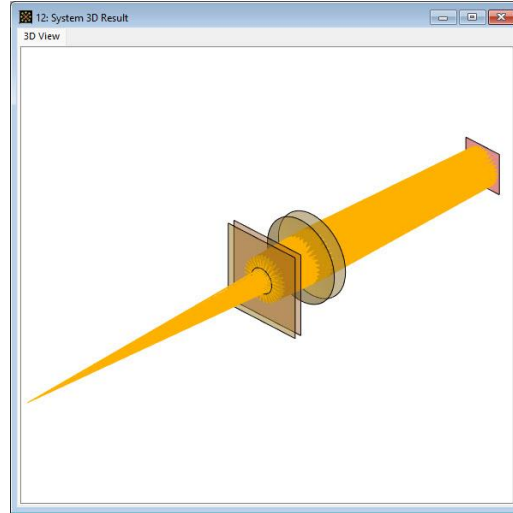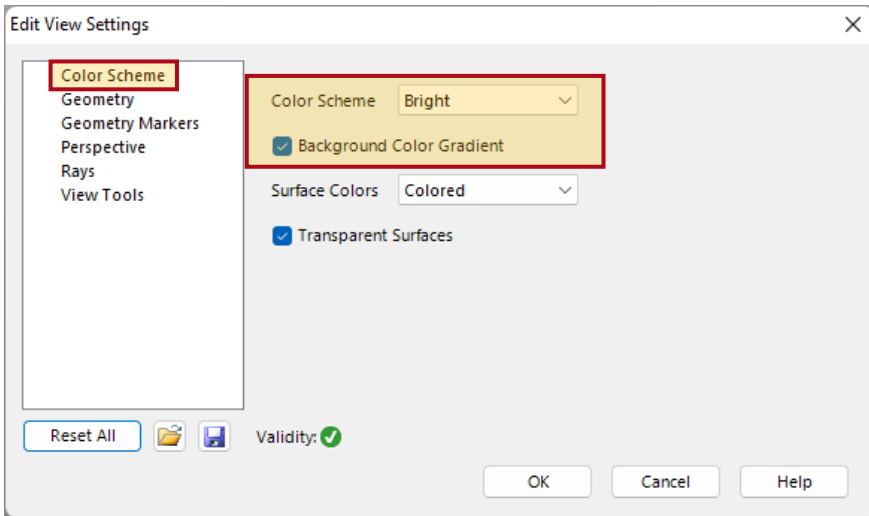
Available color schemes are *Bright*, *Medium* and *Dark*. Furthermore, the user can decide whether to include a *Background Color Gradient* or not.
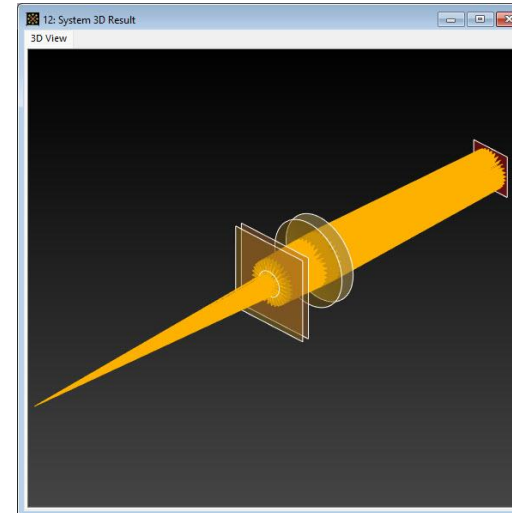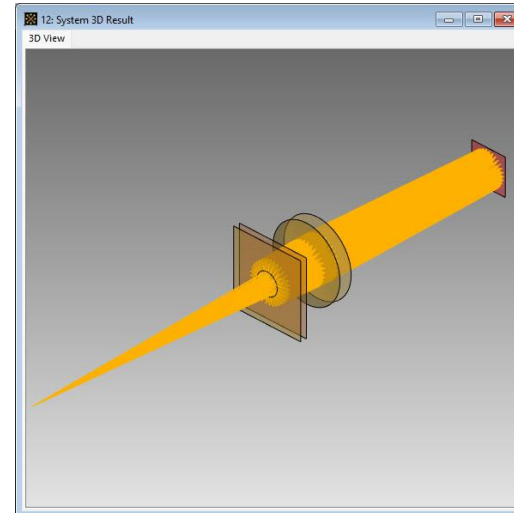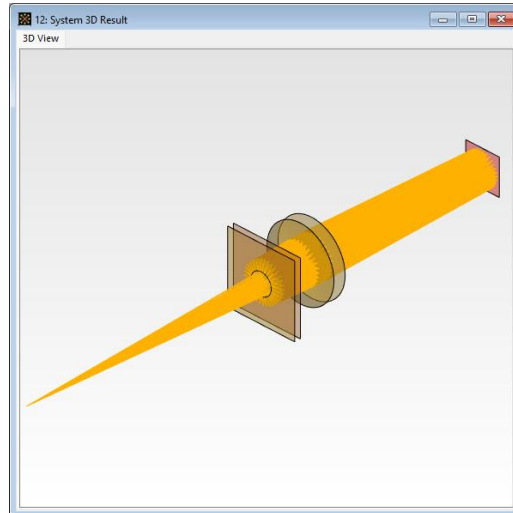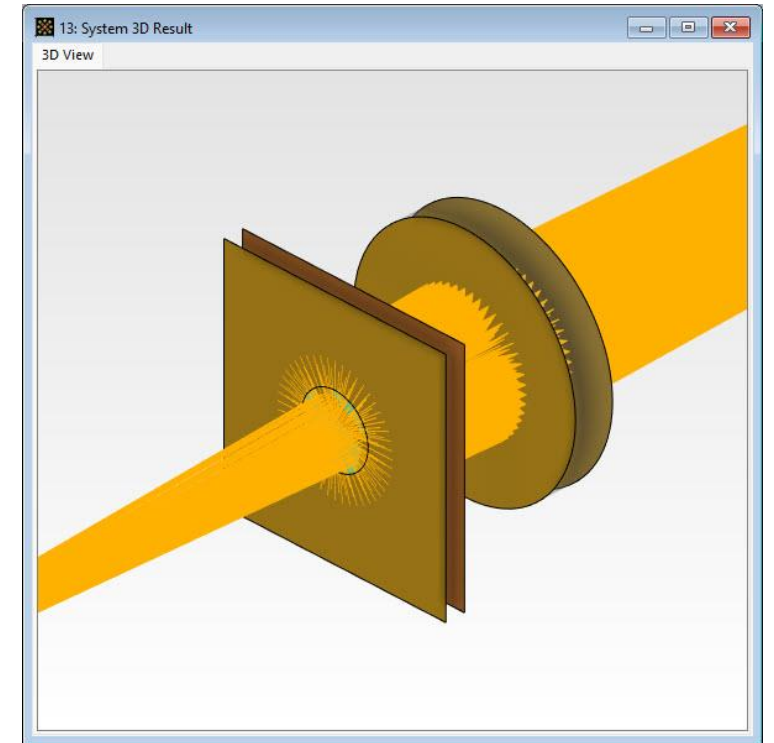
Color Schemes – Components
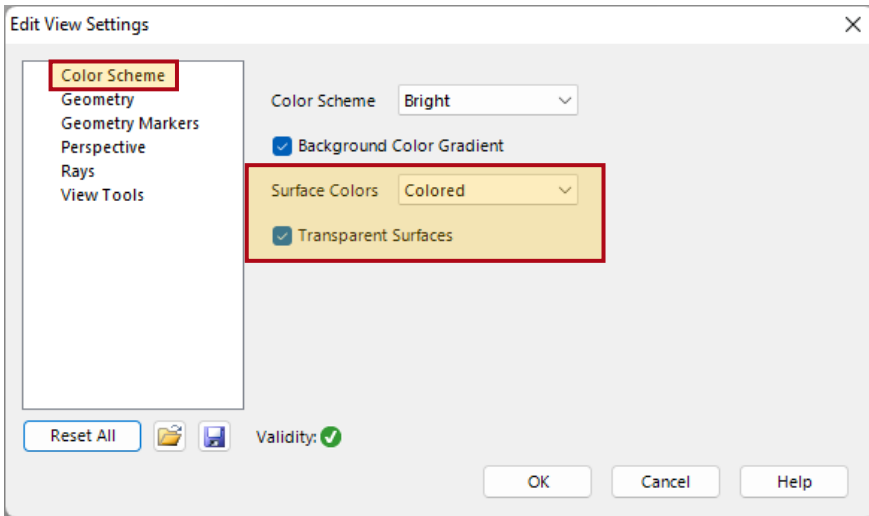
The surfaces of the components can be depicted either *Colored* (green for sources, yellow for components and red for detectors) or *Uncolored*. It is also possible to display them with transparency.
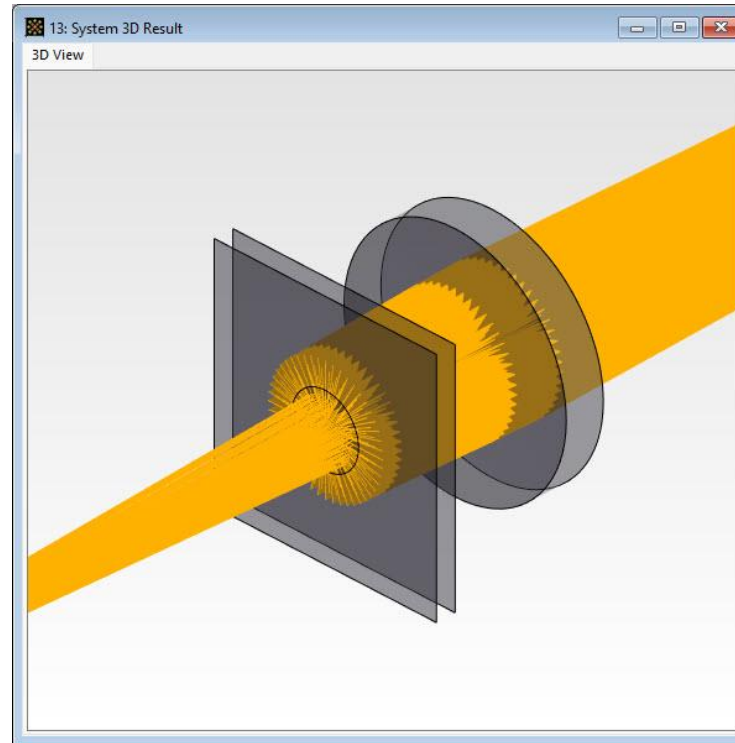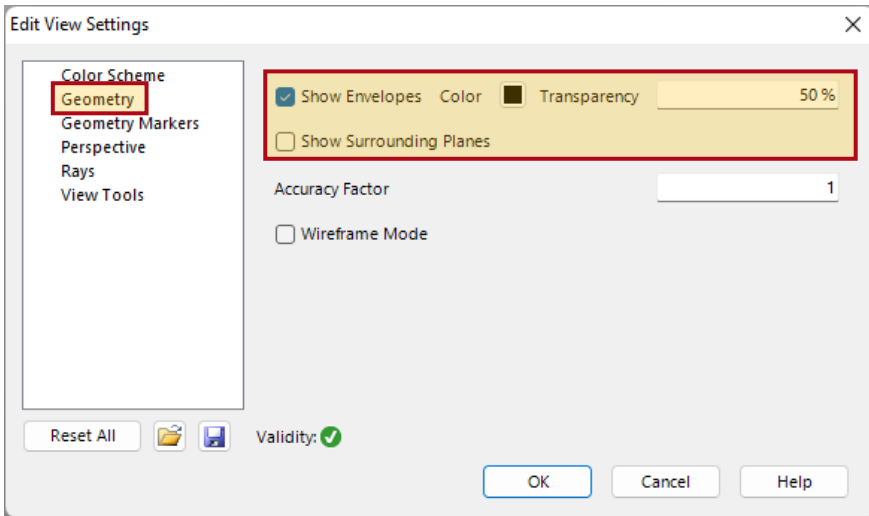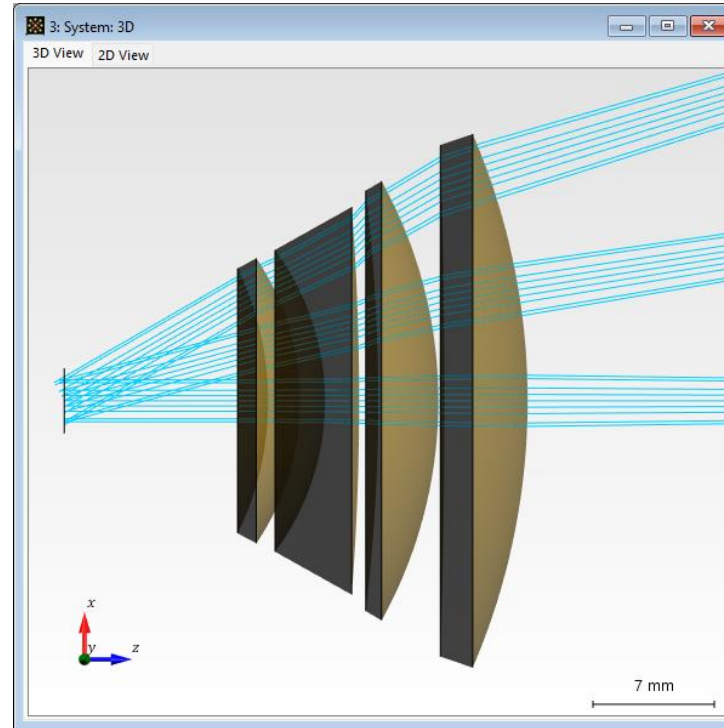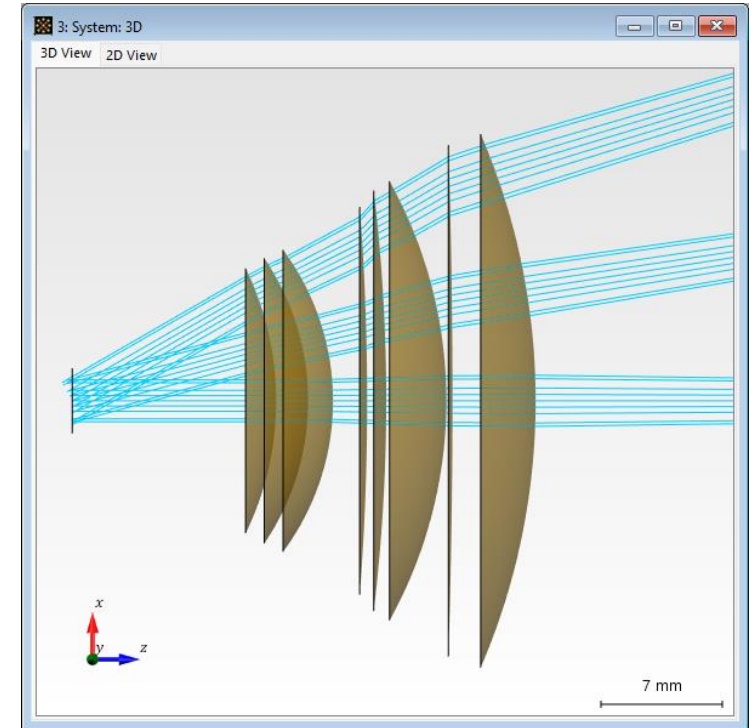
Uncolored surfaces

non-transparent surfaces

Geometry – Envelopes

The *Geometry* tab covers the customization of the depiction of system components, such as lens systems. It is possible to show or hide envelopes of the lenses. The envelopes can also be shown with a certain transparency.

with envelopes   without envelopes

F-Theta Lens - See full use case: Performance Evaluation of an F-Theta Scanning Lens

Geometry – Accuracy Factor

The *Accuracy Factor* controls the sampling of the 3D visualization. An increased *Accuracy Factor* might be helpful for the detailed depiction of structured surfaces or crisp visualization of region borders. However, note that very high values can increase rendering time.
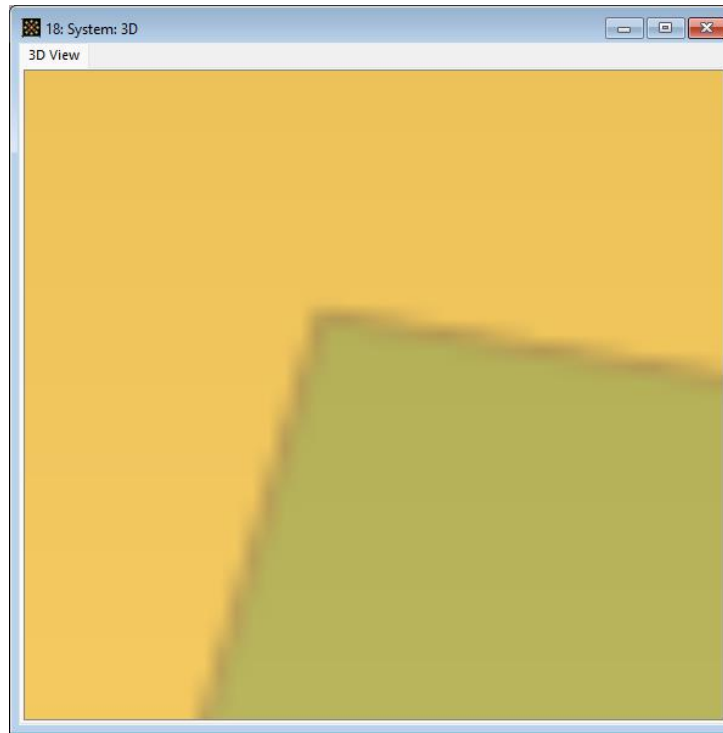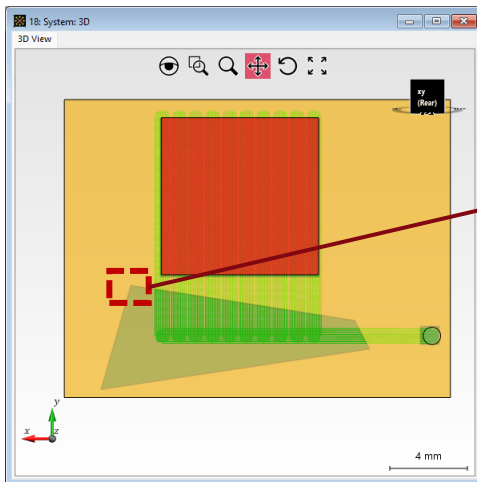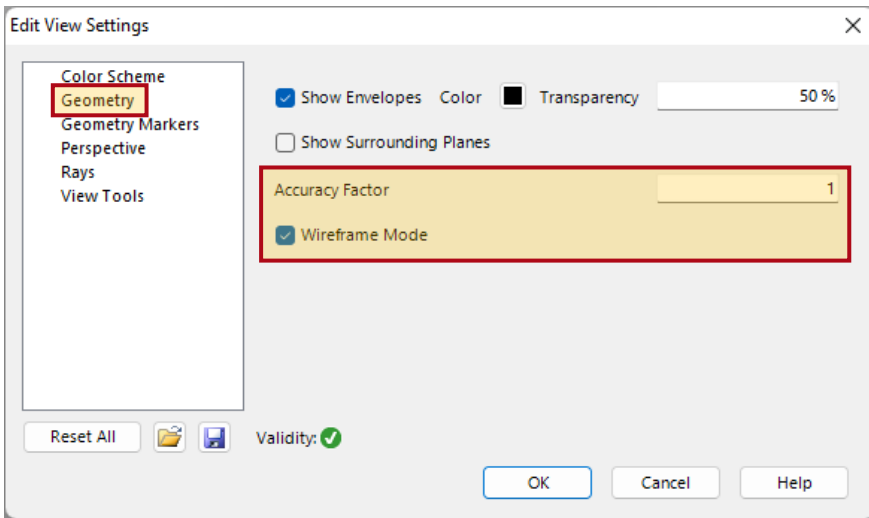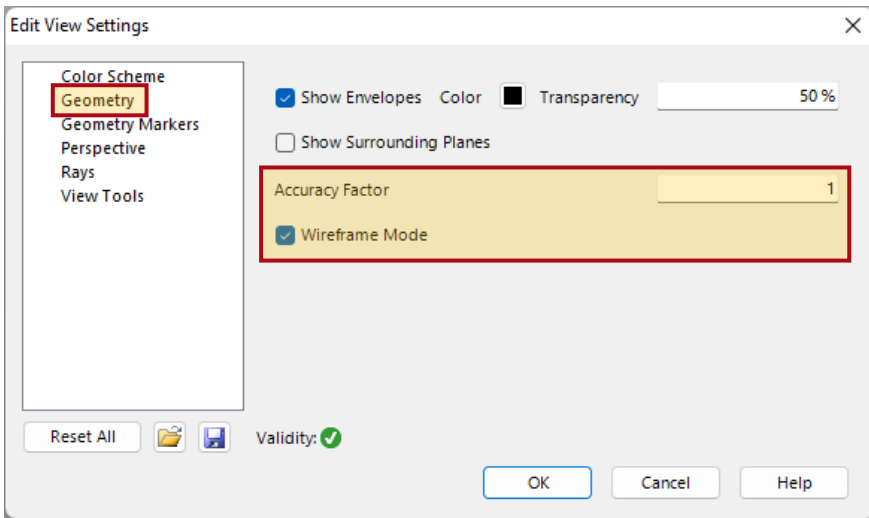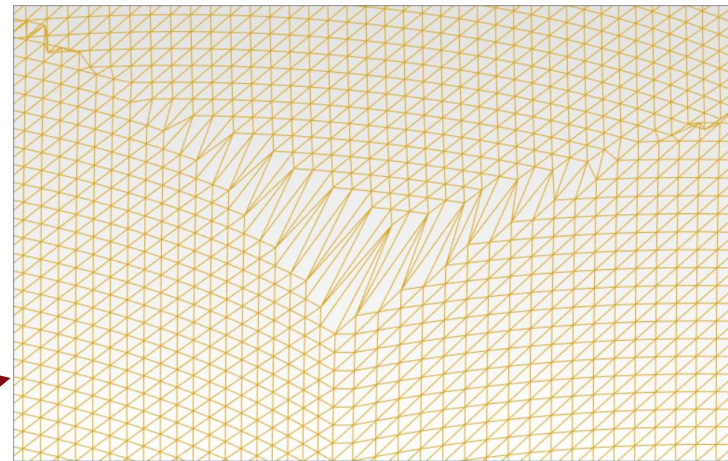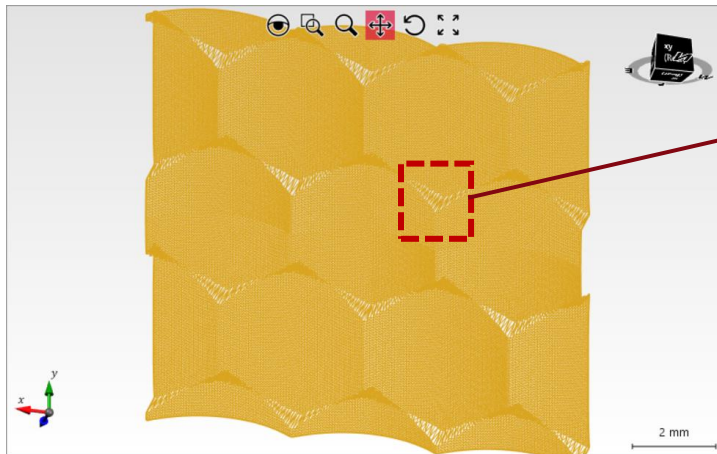

Accuracy Factor: 1
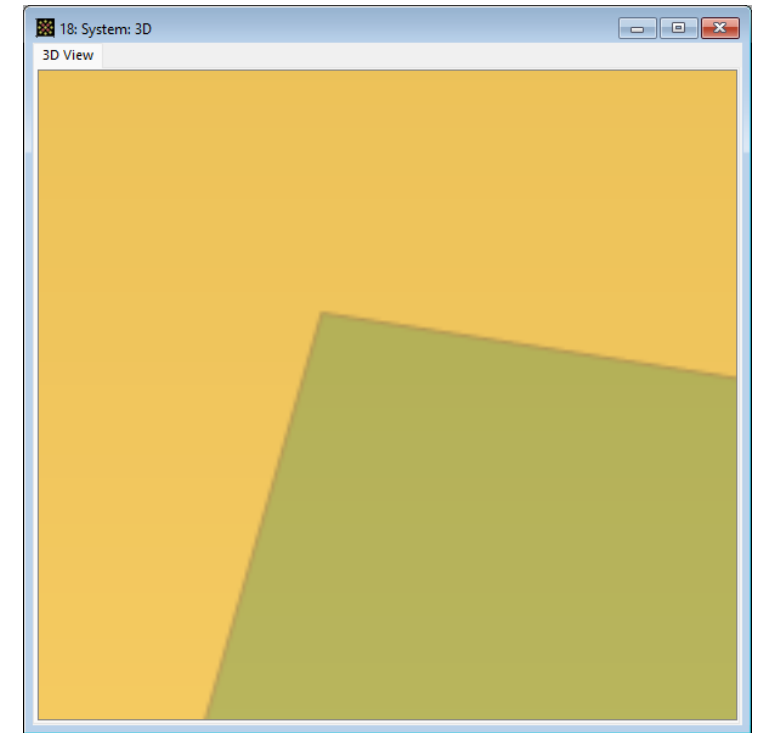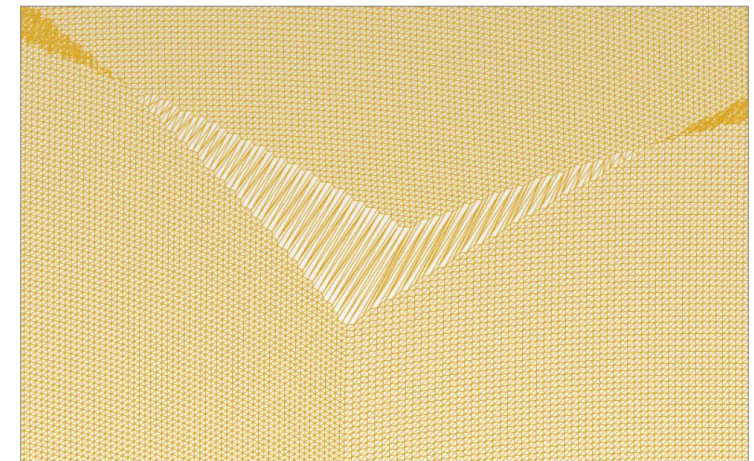
Accuracy Factor: 5

Geometry – Wireframe Mode

Activating the *Wireframe Mode* will display all surfaces in the system through their mesh. The *Accuracy Factor* will retain the same function in this mode.
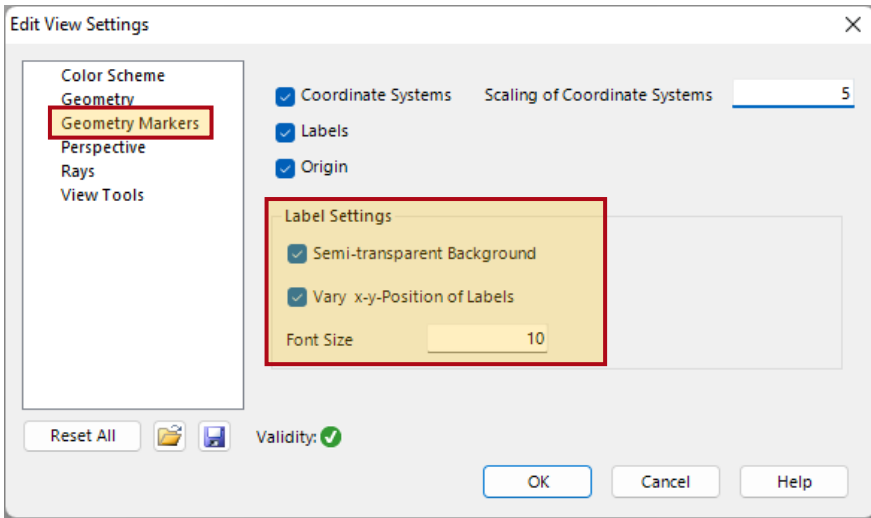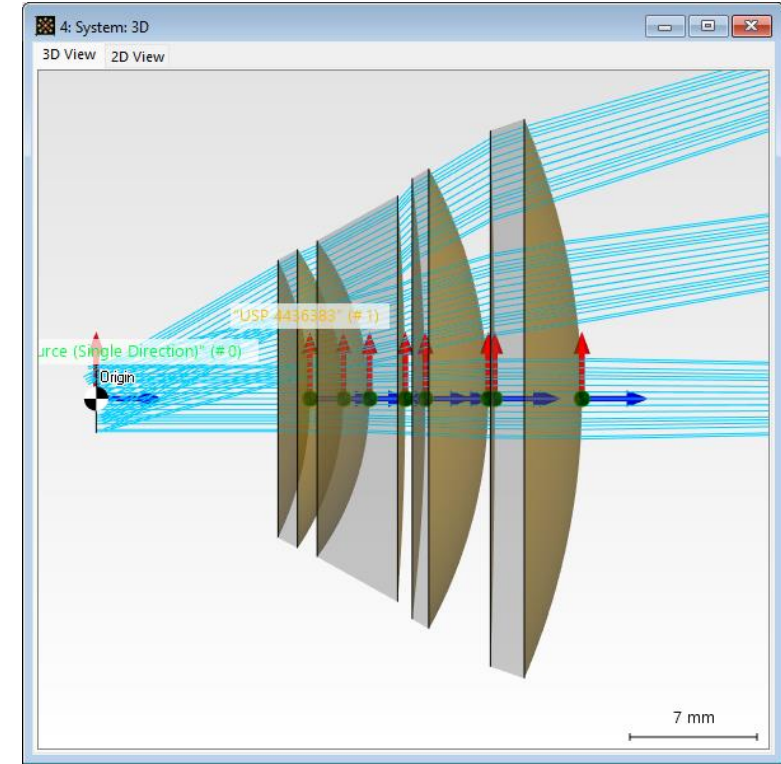

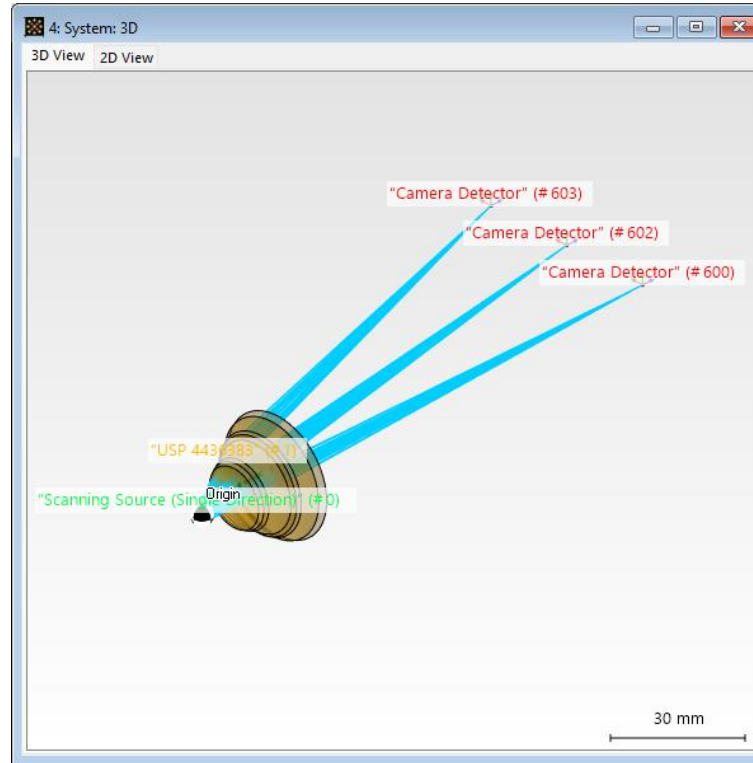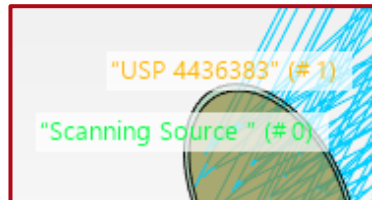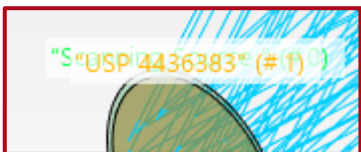*Accuracy Factor*: 1

Accuracy Factor: 3

Geometry Markers

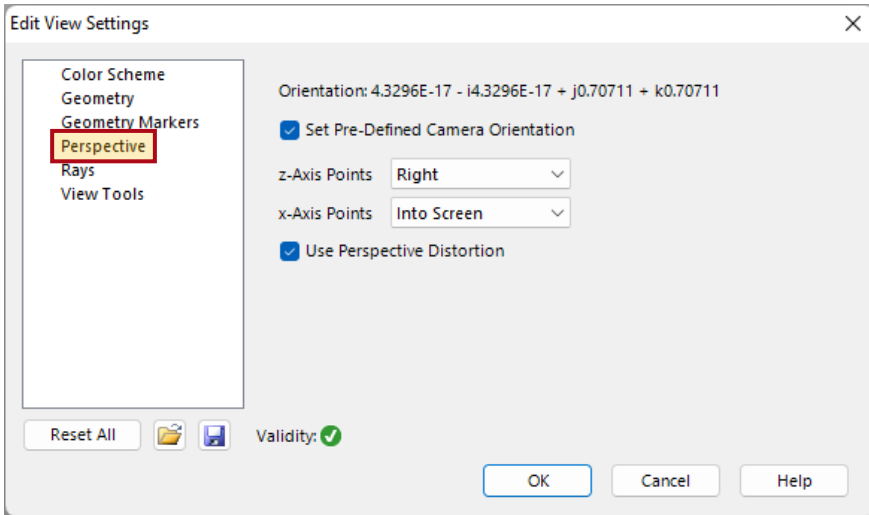
Semi-transparent Background on & off


Vary x-y-Position of Labels on & off

In the *Geometry Markers* panel the display of *Coordinate Systems*, as well as the *Labels* of the elements, can be enabled. In the visualization it is also possible to include the *Origin*, meaning the origin of the global coordinate system (source).

Perspective

Edit View Settings

- Color Scheme
- Geometry
- Geometry Markers
- Perspective
- Rays
- View Tools

Orientation: 4.3296E-17 - i4.3296E-17 + j0.70711 + k0.70711

☑ Set Pre-Defined Camera Orientation

z-Axis Points   Right

x-Axis Points   Into Screen

☑ Use Perspective Distortion

Reset All   Validity: ✓

OK   Cancel   Help

The *Perspective* sub-menu provides options to fix the camera orientation to a desired plane. The current camera orientation is highlighted in the top right corner of the document if the tool *View Cube* is active. Through the control *Use Perspective Distortion,* it is possible to highlight certain planes in the optical setup.
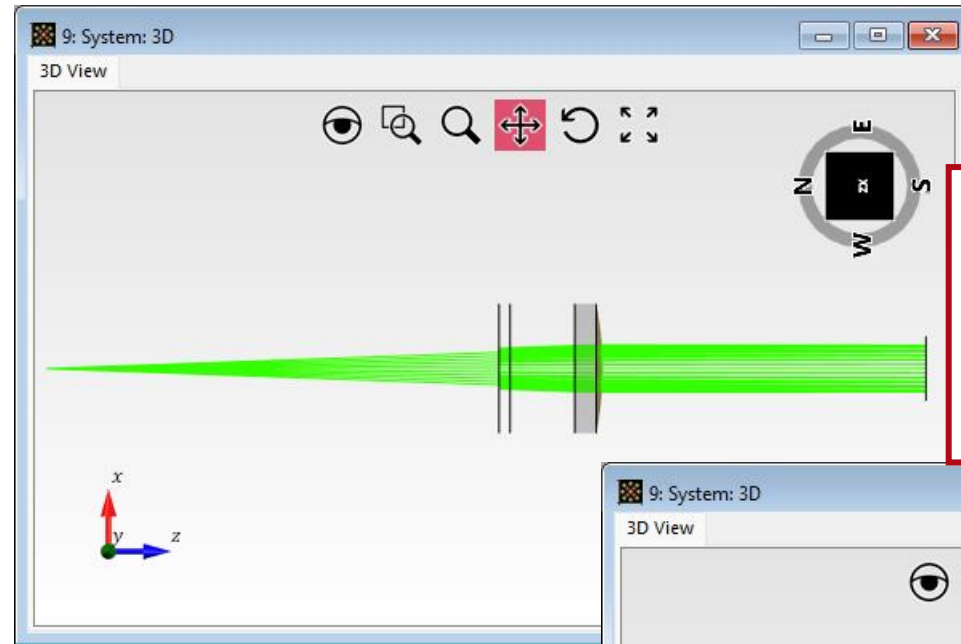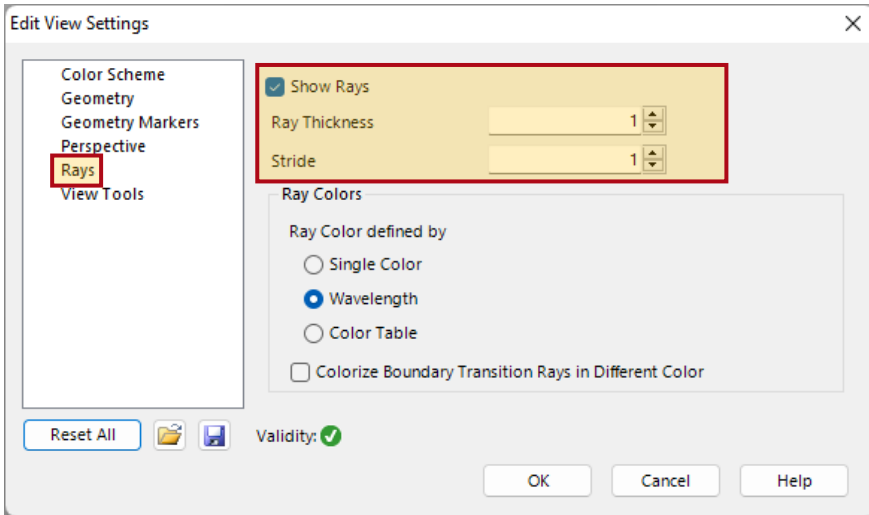
without *Use Perspective Distortion*

Note: While a pre-defined camera orientation will adjust the view to the specified plane, the user can still rotate the view by using the rotation tool.
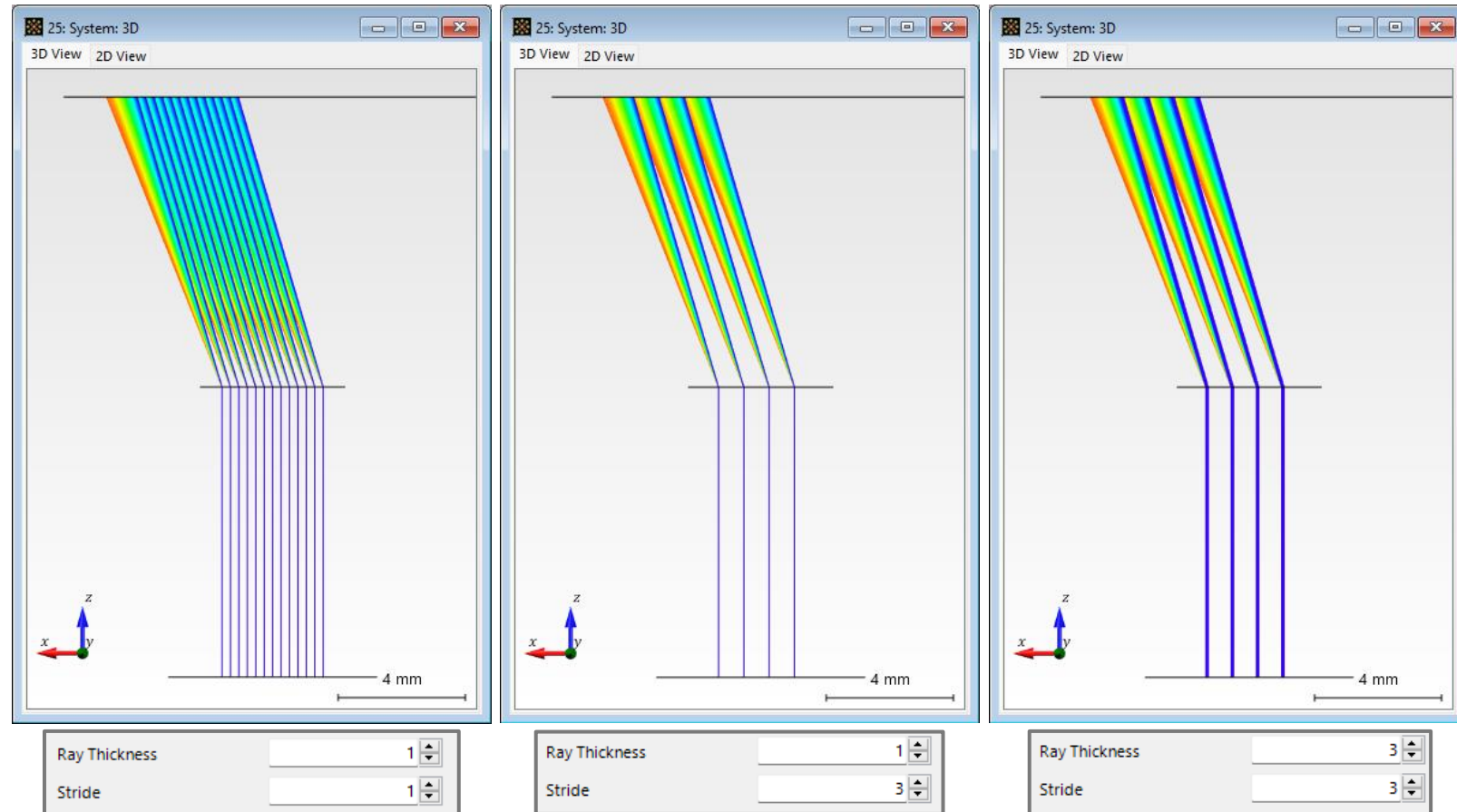
with *Use Perspective Distortion*
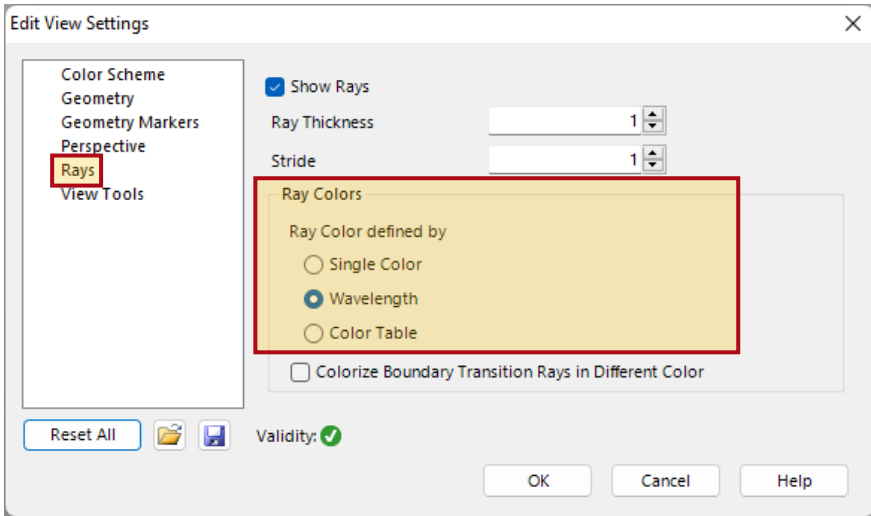
15
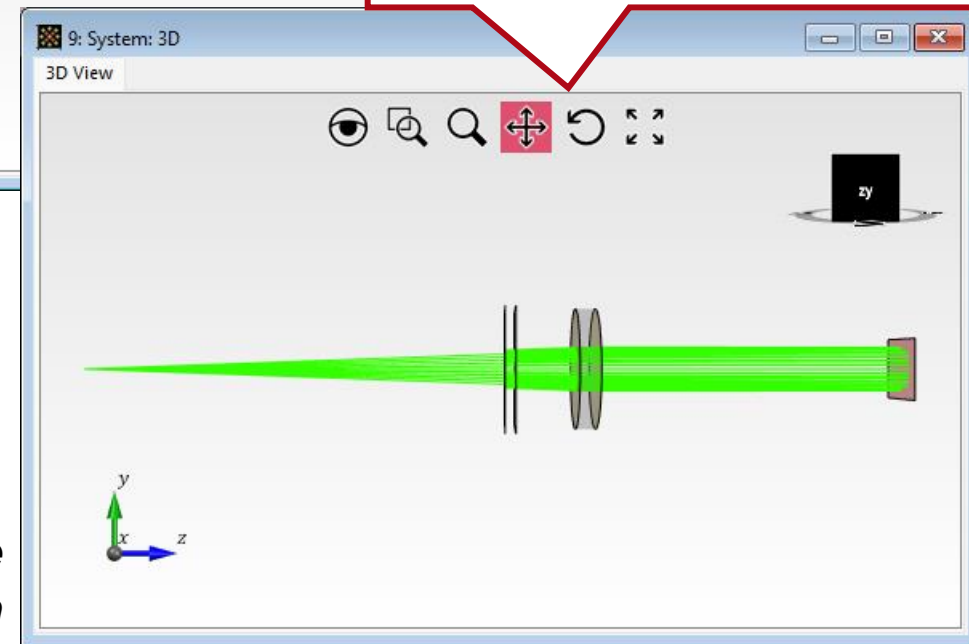
Ray Visualization

The depiction of rays, including their thickness and gap, can be set in the *Rays* tab of the menu.

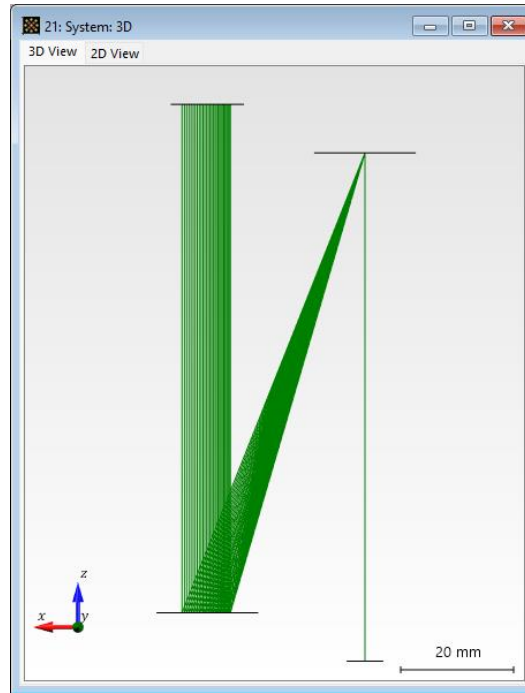*example: ideal transmission grating – 1st order*
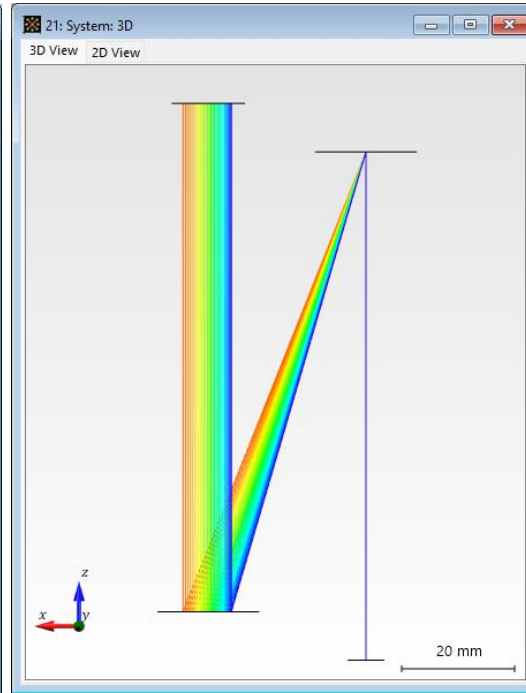

only available for *System: 3D (Ray Result Profile)*

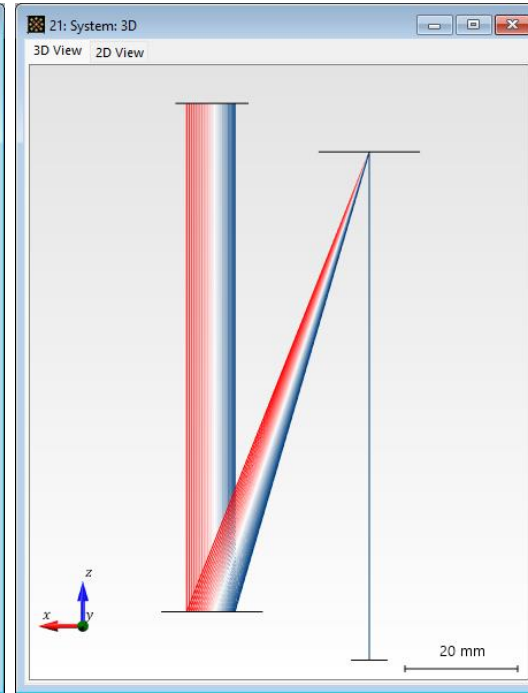# Ray Visualization for Multiple Wavelengths

example: ideal reflection grating doublet – 1st order
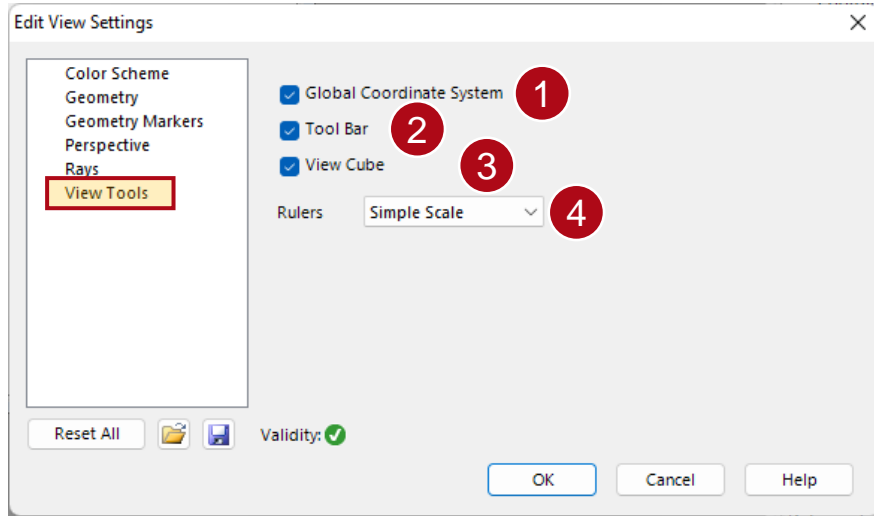
*Single Color* *Wavelength* *Color Table*

For optical systems with multi-wavelength or multi-mode sources, it is also possible to depict the rays according to their wavelength or mode using the real color of the wavelength or a color table.

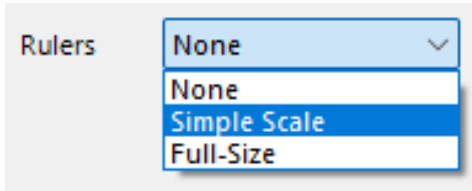only available for *System: 3D (Ray Result Profile)*

View Tools

The panel *View Tools* provides helpful options to display or omit information in the document window, such as the *Global Coordinate System* (1), the *Tool Bar* (2), the *View Cube* (3) and the *Ruler* (4).
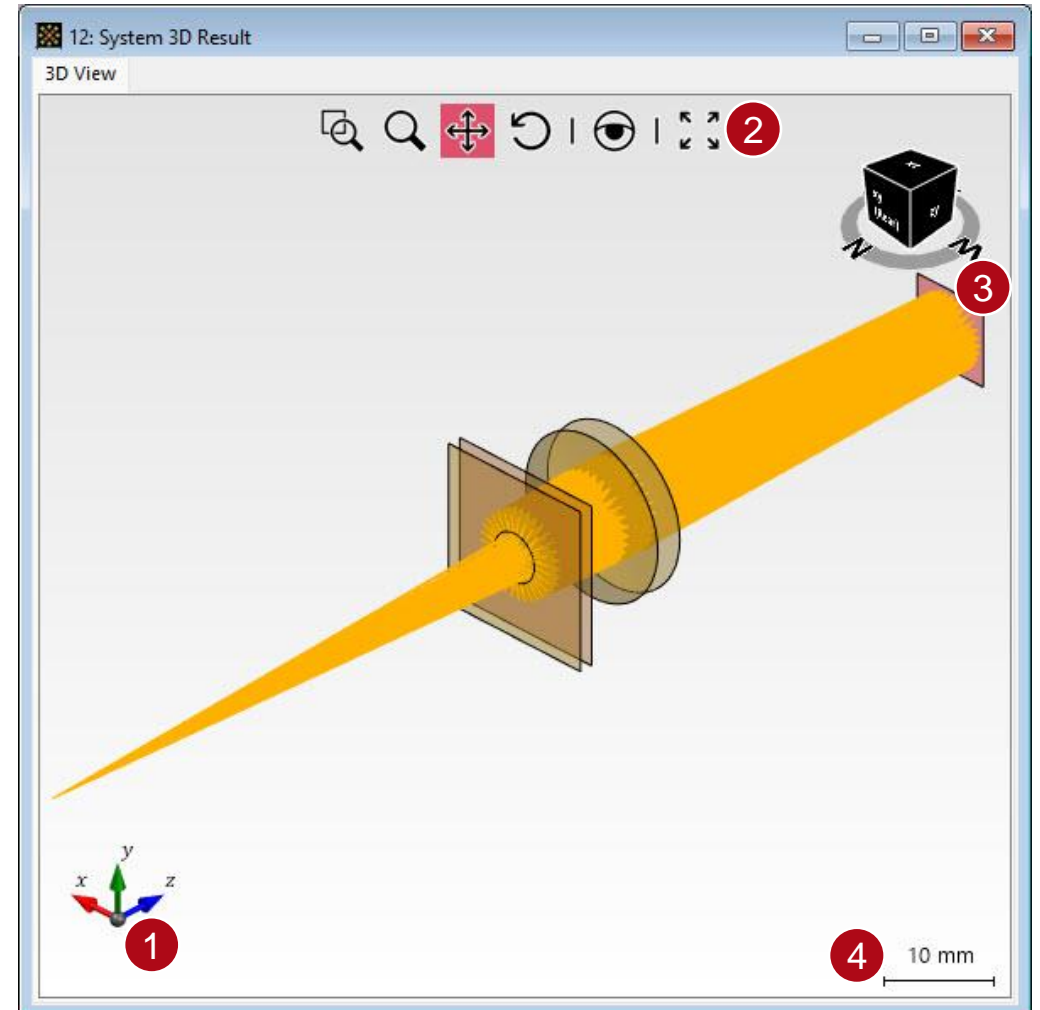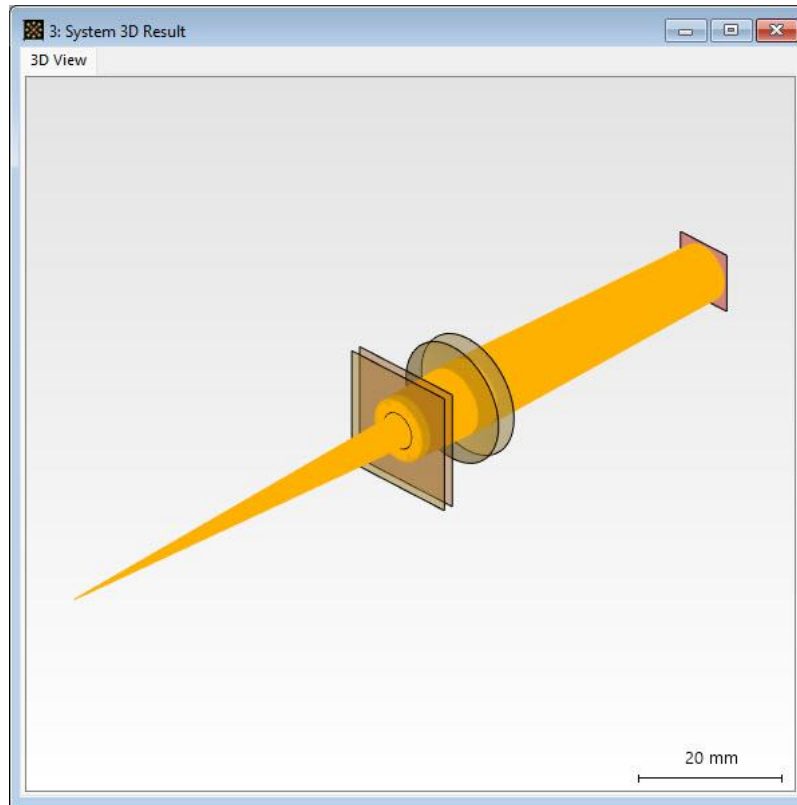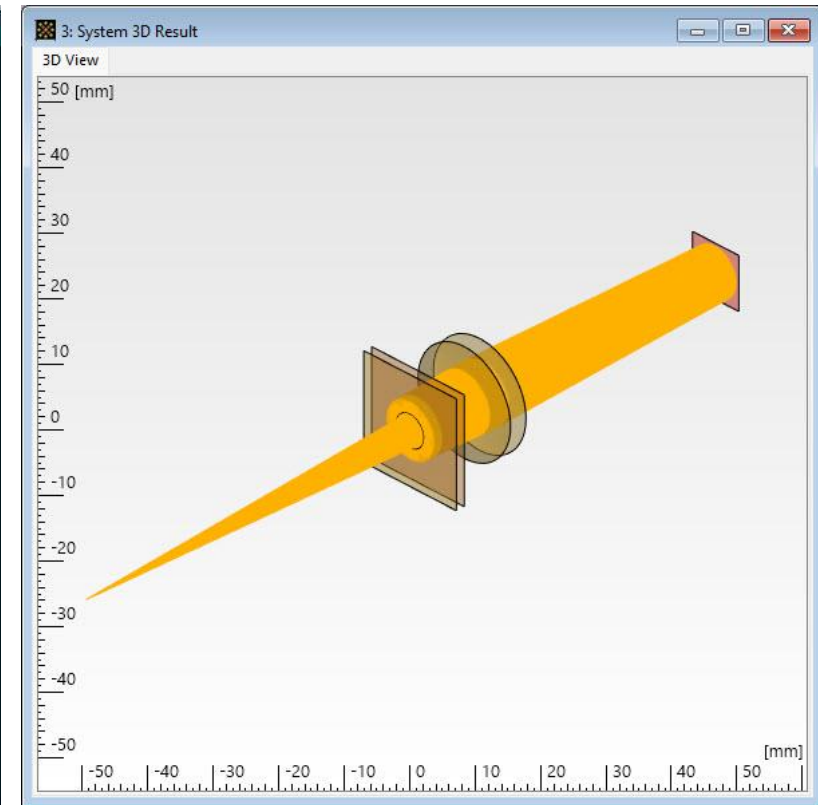
View Tools – Ruler

The different options for the Ruler include a simple and a full-size version. It is also possible to turn it off completely.
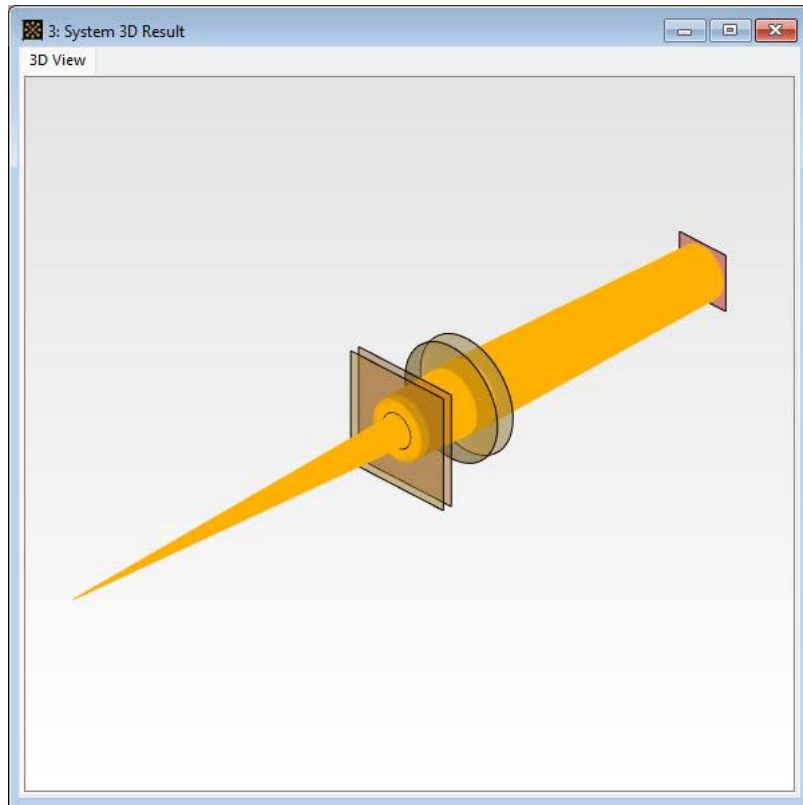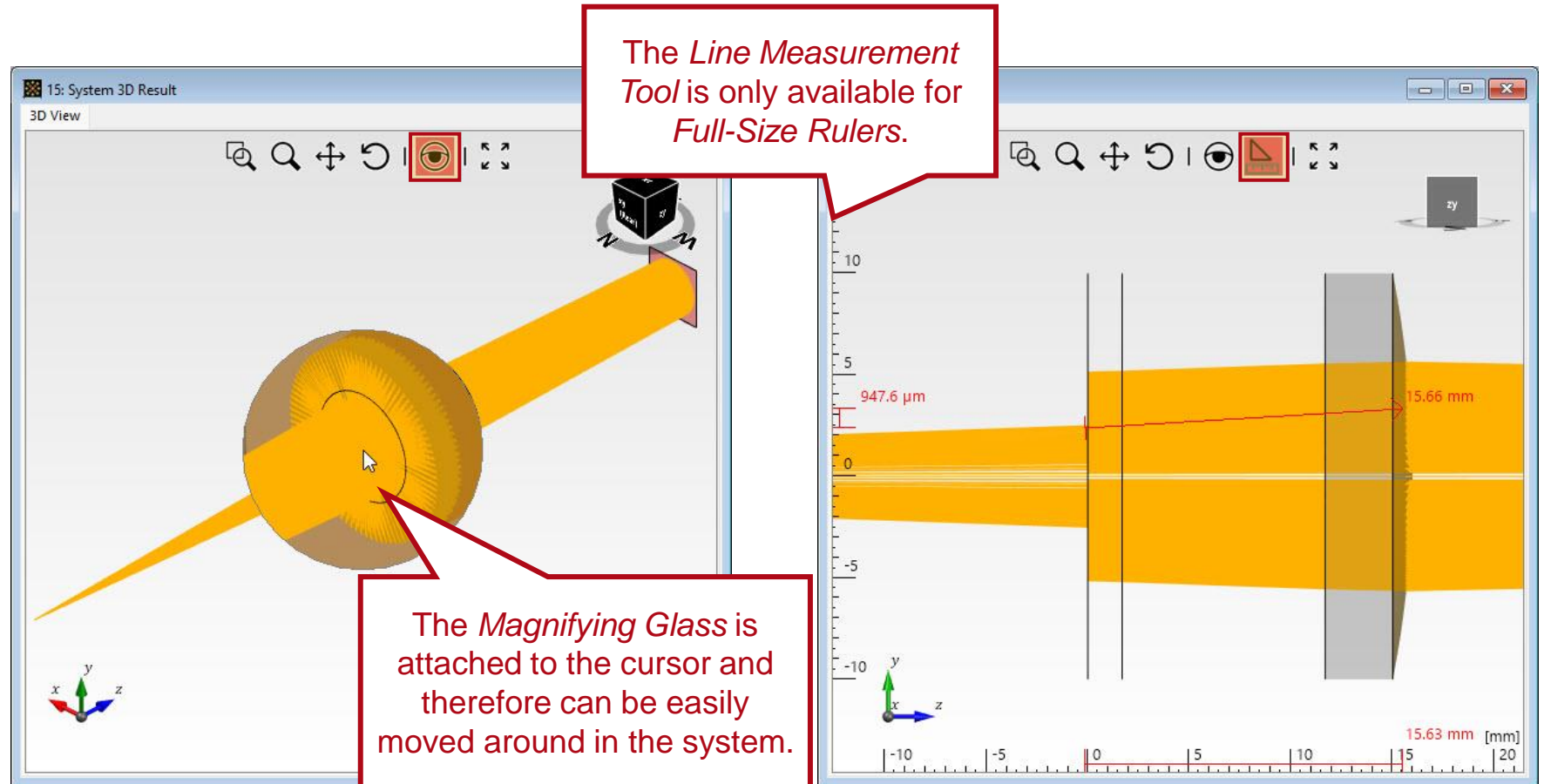


None

Simple Scale

Full-Size

Tips for Positioning

In order to improve the usability, there are a few additional features that we would like to highlight.

The *Line Measurement Tool* is only available for *Full-Size Rulers*.

The *Magnifying Glass* is attached to the cursor and therefore can be easily moved around in the system.

Use the *Magnifying Glass* in the *Tool Bar* to zoom into details without changing the actual system view.

The *Line Measuring Tool* allows for an easy analysis of the distances and sizes of the various components.

Tips for Fast Access
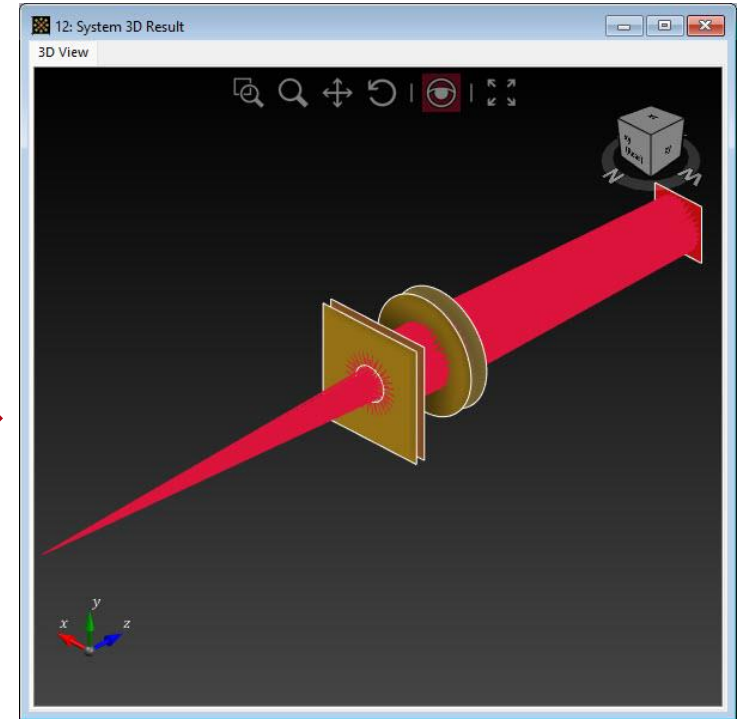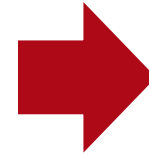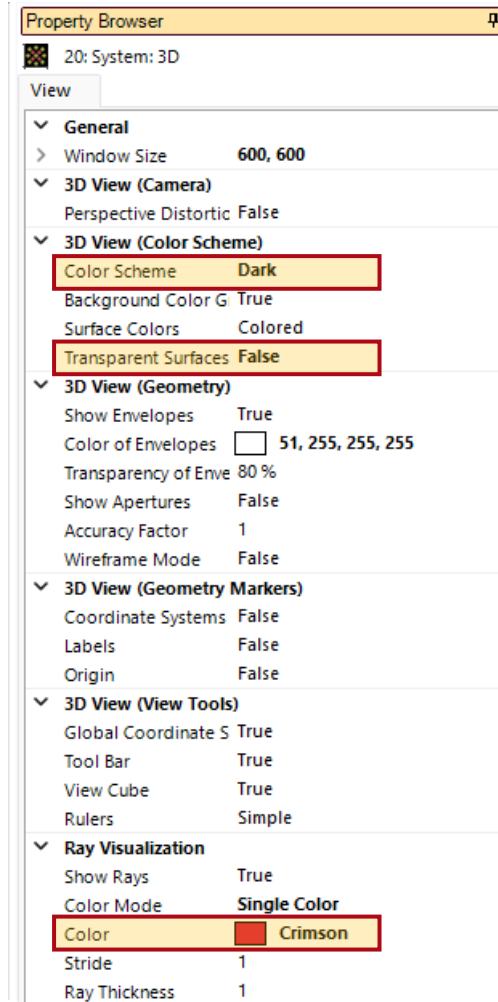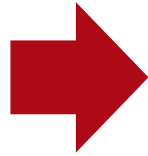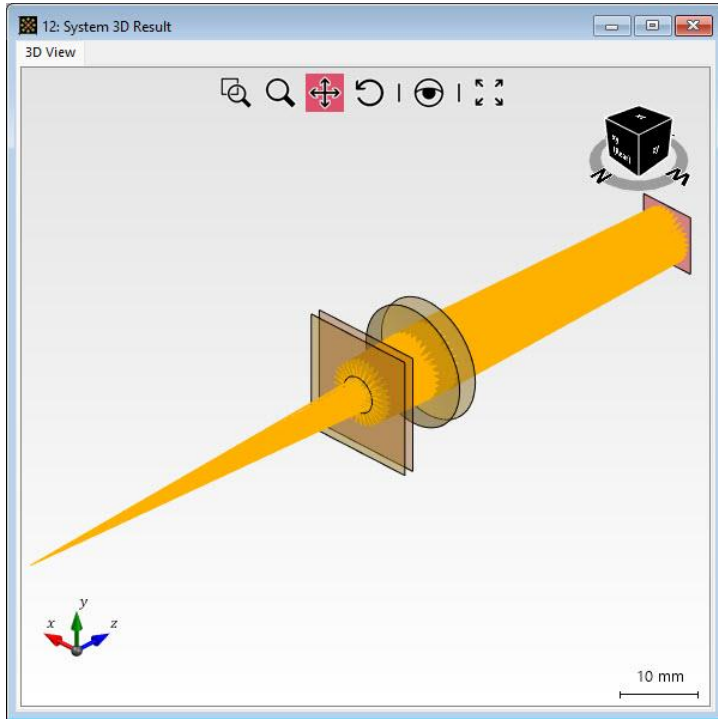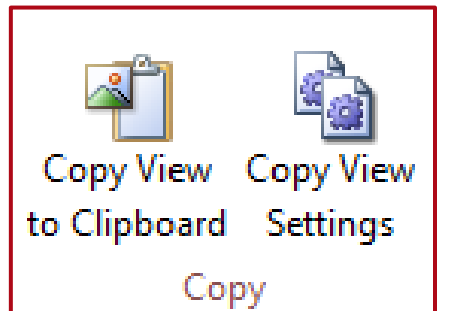

Most options can be quickly accessed via the *Property Browser*.

In the *View* ribbon, you will also find tools to quickly copy settings from one document to another.

Document Information

title	3D Visualization of Optical Systems
document code	SWF.0015
document version	1.1
software edition	VirtualLab Fusion Standard
software version	2023.2 (Build 1.242)
category	Feature Use Case
further reading	• Configuring Your Simulation in VirtualLab Fusion • Performance Evaluation of an F-Theta Scanning Lens • Examination of Sodium D Lines with Etalon